6. Linkage Analysis and TMDL (Load Capacity)

The linkage analysis component of the TMDL establishes the relationship between nutrient loading and numeric targets and defines the total maximum daily load (TMDL) or loading capacity of receiving waters in order to determine the reductions required to attain the desired water quality (as expressed by the numeric targets (US EPA, 1999)). The linkage can be based on a long-term set of monitoring data that allow for an evaluation of waterbody response to flow and loading conditions. However, if the data are not available to develop this relationship, linkage can be established by the use of analytical tools (including simulation models) and/or best professional judgment.

In order to determine the phosphorus TMDL (load capacity) for both Lake Elsinore and Canyon Lake, models used to predict the annual and seasonal phosphorus concentrations in stratified and polymictic lakes (shallow lakes that mix every few days or even daily all year round) (Nürnberg, 1998), were evaluated for applicability. These models and methods proved to be not applicable to Lake Elsinore and Canyon Lake due to the extremely long hydraulic residence time for both lakes. Another common lake model, BATHTUB, has been used in the past to simulate the water quality for both lakes (Anderson, 2001, Anderson and Oza, 2003). For Lake Elsinore, the BATHTUB model simulated phosphorus concentration adequately close to the measured results for year 2000-2001; however, the model could not accurately simulate phosphorus and nitrogen concentrations for other years and other hydrological conditions. For Canyon Lake, the BATHTUB model poorly predicted the water quality, even for the 2001-2002 period when the nutrient budget was developed. In addition, the BATHTUB model requires input of nutrient budget data that were not available for either lake, other than the two specific years when the nutrient budgets were developed. The BATHTUB model also assumes a constant internal loading rate not dependent on water column concentration. However, a preliminary study by Anderson (2002) has shown that the water column phosphorus concentrations positively correlate to the internal phosphorus loading. For these reasons, to develop the nutrient TMDLs for Lake Elsinore and Canyon Lake, staff relied on nutrient mass balance models developed specifically for the lakes based on historical data. Similar nutrient mass balance models have also been used for other lake TMDLs (e.g., Walker, 2000).

6.1 Lake Elsinore Total Phosphorus (TP) Concentration Model

Using historical water quality data from 1992-1997 and 2000-2002, Dr. Anderson developed a simple steady-state phosphorus (referred to as TP) model for Lake Elsinore in order to determine the allowable phosphorus load to meet numeric targets under various loading scenarios (Anderson, 2002). A discussion of the derivation and verification of the model is presented in Appendix B.

For moderate and dry conditions, under steady-state conditions, i.e., no change in the lake volume and no change in the water column concentration (as represented by the proposed numeric target), the allowable external load to Lake Elsinore is represented by equation 1:

Equation 1: $Q_{in}C_{in}$ (external TP load) = (C_{ss} v_s – (k+r) C_{sed}) * V/H

where:
Q_{in} = flow entering Lake Elsinore (m^3/yr)
C_{in} = TP concentration entering Lake Elsinore (mg/L)
C_{ss} = in-lake TP concentration (mg/L) ***(numeric target)***
v_s = phosphorus settling rate of 37.4 m/yr
k = internal TP loading rate of 0.0156 m/yr
r = TP re-suspension velocity of 0.0021 m/yr
C_{sed} = volumetric sediment TP concentration of 247,000 mg/m^3
V = lake volume of (m^3)
H = average lake depth (m)

This equation links external load ($Q_{in}C_{in}$) and internal load (represented as ((k+r)C_{sed}) to in-lake TP concentration (C_{ss}) and can be used to calculate the nutrient loading capacity for the proposed numeric targets. Estimates for the constants v, k, r, and C_{sed} are based on historical data and recent studies (Anderson, 2002). Substituting the values for settling rate (v_s), internal TP loading rate (k), TP re-suspension rate (r) and sediment TP concentration (C_{sed}) which are assumed to be constant, yields a linear relationship between the C_{ss} (TP numeric target) and the TP load capacity (Q_{in}*C_{in}) as shown in equation 2.

Equation 2: $Q_{in}C_{in}$ (external TP load, in kg/yr) = (37.4*TP target – 4371.9) * V/H*10^{-6}

Phosphorus Load Capacity for Lake Elsinore Based on Proposed Interim Target

Substituting the proposed interim phosphorus numeric target of 0.1 mg/L (or 100 mg/m^3) into equation 2 results in an external TP load (Q_{in}*C_{in}) that has to be negative in order to meet the proposed numeric target. This means that without any reduction in internal load, it would be impossible to achieve the numeric target even when the external load is zero. Assuming that there is no external TP load entering Lake Elsinore, the internal loading rate (k), would have to be reduced from the current rate of 0.0156 m/yr to 0.013 m/yr., a 16 % reduction to achieve the proposed numeric target of 0.1 mg/L. Put another way, **in order to achieve the proposed TP numeric target of 0.1 mg/L, no external phosphorus load into Lake Elsinore can be allowed <u>and</u> at the same time, the internal sediment phosphorus load would need to be reduced by 16% under moderate and dry conditions.**

Staff does not believe that it is feasible to restrict all external loads to Lake Elsinore. In addition, under dry conditions, the predominant source of nutrients is the lake sediment. It is expected that Lake Elsinore water quality will not improve unless there is a significant reduction in internal loading. Staff evaluated methods to reduce the internal sediment loading. Limnocosm experiments on Lake Elsinore showed that alum was the most effective treatment for reducing the internal loading of phosphorus, completely stopping phosphorus release from the sediments over several months (Anderson, 2000). However, additional studies show that for Lake Elsinore as a whole, alum treatment is not feasible at the present due to the high pH of the Lake (Anderson, 2001). Calcium addition reduced ortho-phosphate (PO_4-P) flux by 65%. But this effect is considered to be short-term, and the long-term efficacy of calcium treatment is unknown. Aeration to maintain the dissolved oxygen at or near 7 mg/L, reduced PO_4-P release by 35% (Anderson, 2000). Currently, an aeration system is being planned for Lake Elsinore by LESJWA. Therefore, staff is using the 35% phosphorus reduction rate for the expected reduction in the internal sediment load to calculate the phosphorus load capacity in order to achieve the interim target.

Table 6-1 lists the allowable external total phosphorus load to Lake Elsinore in order to achieve the interim phosphorus target of 0.1 mg/L, assuming the 35% reduction in internal loading of phosphorus. As shown, the allowable external load is correlated with lake elevation and volume: as the lake elevation and volume increase, greater amounts of phosphorus can be discharged to Lake Elsinore and still ensure that the proposed interim phosphorus numeric target of 0.1 mg/L will be met. These results are presented graphically in Figure 6-1.

For wet conditions when Lake Elsinore overflows to Temescal Creek, as occurred in 1993, 1995 and 1998, the allowable total phosphorus load can be expressed by equation 3:

Equation 3:

$Q_{in}C_{in}$ (external TP load in kg/yr) = $Q_{out}C_{out}$ + ((TP target * v_s – (k+r) C_{sed}) * V/H

where:

Q_{in} = flow entering Lake Elsinore (m^3/yr)
C_{in} = TP concentration entering Lake Elsinore (mg/L)
C_{ss} = in-lake TP concentration (mg/L) ***(numeric target)***
v_s = phosphorus settling rate of 37.4 m/yr
k = internal TP loading rate of 0.0156 m/yr
r = TP re-suspension velocity of 0.0021 m/yr
C_{sed} = volumetric sediment TP concentration of 247,000 mg/m^3
V = lake volume of (m^3)
H = average lake depth (m)
Q_{out} = outflow leaving Lake Elsinore
Q_{in} = TP concentration of the outflow (in-lake TP concentration is used)

The only available data for overflows from Lake Elsinore were obtained during rainfall events in 1995. Q_{out} was 26,815 acre-feet (or 33,000,000 m^3/yr), C_{out} was = 0.1 mg/L, and the lake elevation was 1255 ft. Again, assuming an aeration system will reduce the internal sediment phosphorus loading rate (k) by 35%, the allowable TP load from external sources is then calculated to be 13,726 kg/yr (Table 6-1). This translates to a 32% increase of the allowable TP load compared to the TP load calculated under conditions when Lake Elsinore does not overflow (*e.g*, 10,428 kg/yr at 1255’, no spill).

Table 6-1. Total external phosphorus TMDL for Lake Elsinore to achieve interim TP target of 0.1 mg/L after 35% reduction in internal loading rate

Elevation* (ft)	Volume (AF)	Volume (m^3)	Average Depth (ft)	Average Depth (m)	TP TMDL (kg/yr)
1230	12,000	14,760,000	5.2	1.6	6,670
1240	38,519	47,378,370	12.5	3.8	8,907
1250	71,443	87,874,890	20.6	6.3	10,024
1255	89,114	109,610,220	24.7	7.5	10,428
Lake Elsinore spills at greater than 1255'					13,726
Average					**9,951**

* Typical Lake Elsinore elevation under wet conditions is 1250’ or greater. Under moderate conditions, the lake elevation ranges from 1245 to 1250’; under dry conditions, lake elevation is below 1245’ (or completely dry).

It is important to note that these calculations do not take into account the cumulative effect of nutrient loads on the lake. For example, as just explained, the nutrient loads that can be discharged to the lake are higher during wet weather, when additional flow and lake volume result in compliance with the target phosphorus concentrations. However, this overlooks the fact that the nutrient loads contributed in wet weather have the potential to remain in the lake, where they may provide an ongoing source of internal nutrient loading. A TMDL approach that fails to account for these cumulative effects would frustrate efforts to reduce internal nutrient loading. Thus, Table 6-1 also specifies the average nutrient loads necessary to achieve the interim phosphorus target. Use of average loads will help to address cumulative effects and, as discussed at the end of Section 5, will facilitate implementation of the TMDL and determination of compliance.

Phosphorus Load Capacity for Lake Elsinore Based on the Proposed Final Target

Similarly, substituting the proposed final phosphorus numeric target of 0.05 mg/L (or 50 mg/m^3) into equation 2 results in an external phosphorus load (Q_{in}*C_{in}) that has to be negative in order to meet the proposed numeric target. Assuming that there is no external phosphorus load entering Lake Elsinore, the internal loading rate (k) would have to be reduced from the current rate of 0.0156 m/yr to 0.0055 m/yr, a 65 % reduction, to achieve the proposed numeric target of 0.05 mg/L. To allow any external phosphorus loading into Lake Elsinore, a greater than 65% reduction in phosphorus internal loading rate has to be achieved. Literature review has shown that alum treatment has a long-term effect (10-20 year) of reducing the internal phosphorus loading rate by 70% (Welch and Cooke, 1999). Assuming that alum treatment becomes feasible in the future for Lake Elsinore, and/or that other in-lake treatments, separately or cumulatively, reduce the internal phosphorus loading rate by 70% (k of 0.00468 m/yr), the allowable external load to Lake Elsinore in order to achieve the proposed final phosphorus target of 0.05 mg/L was calculated for different lake elevations/volumes (Table 6-2). These results are presented graphically in Figure 6-2. As for the interim target, the average load needed to comply with the proposed final target is also shown in Table 6-2.

Figure 6-2 shows that even with a 70% reduction in the internal loading rate, the allowable phosphorus load from external sources (load capacity) to Lake Elsinore would need to be very small to achieve the proposed 0.05 mg/L final phosphorus target. Recognizing the uncertainty and difficulty of both achieving a 70% internal phosphorus loading reduction and essentially eliminating external phosphorus loading, 0.05 mg/L of phosphorus is proposed as a long-term target, with compliance to be achieved by 2019. However, staff believes that compliance with the proposed interim target of 0.1 mg/L is achievable in the relatively short term, in light of the expected implementation of an aeration system for the lake.

Table 6-2.Total external phosphorus TMDL for Lake Elsinore to achieve final TP target of 0.05 mg/L after 70% reduction in internal load rate

Elevation* (ft)	Volume (AF)	Volume (m^3)	Average Depth (ft)	Average Depth (m)	TP TMDL (Kg/yr)
1230	12,000	14,760,000	5.2	1.6	1,818
1240	38,519	47,378,370	12.5	3.8	2,428
1250	71,443	87,874,890	20.6	6.3	2,732
1255	89,114	109,610,220	24.7	7.5	2,842
1260	107,877	132,688,710	27.8	8.5	3,057
Lake Elsinore spill at greater than 1255'					4,491
Average					**2,895**

* Typical Lake Elsinore elevation under wet conditions is at 1250' or greater. Under moderate conditions, the lake elevation ranges from 1245 to 1250'; under dry conditions, lake elevation is below 1245' (or completely dry).

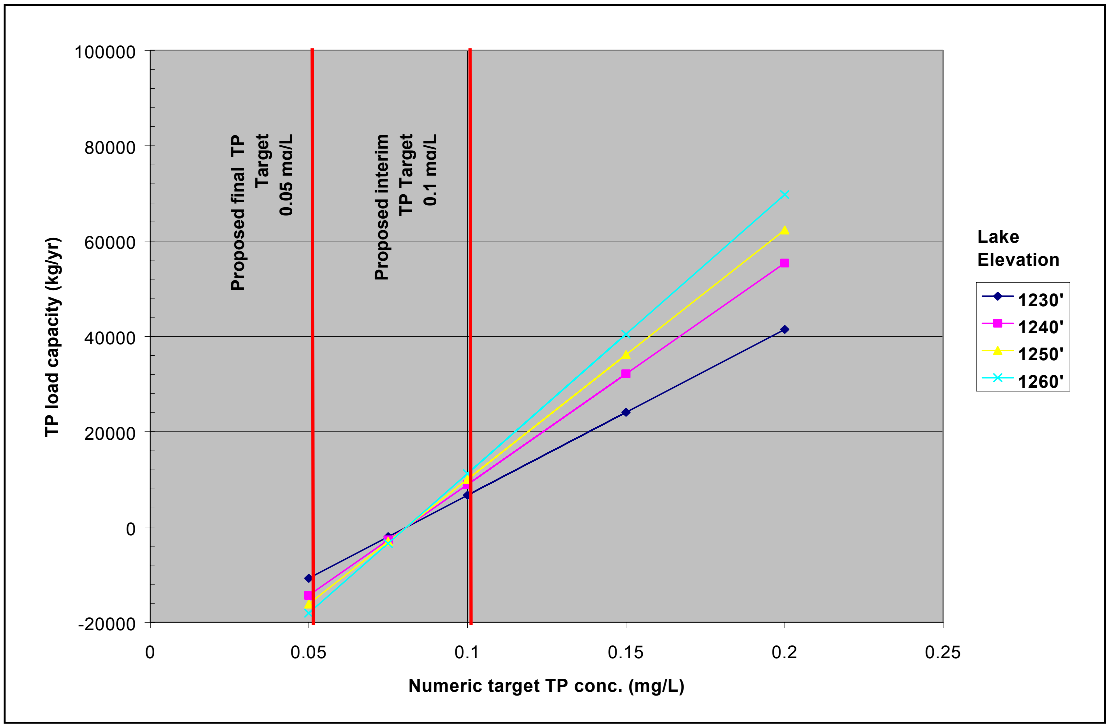

Figure 6-1. Total phosphorus load capacity of Lake Elsinore under different in-lake total phosphorus concentrations assuming 35% reduction in internal loading rate

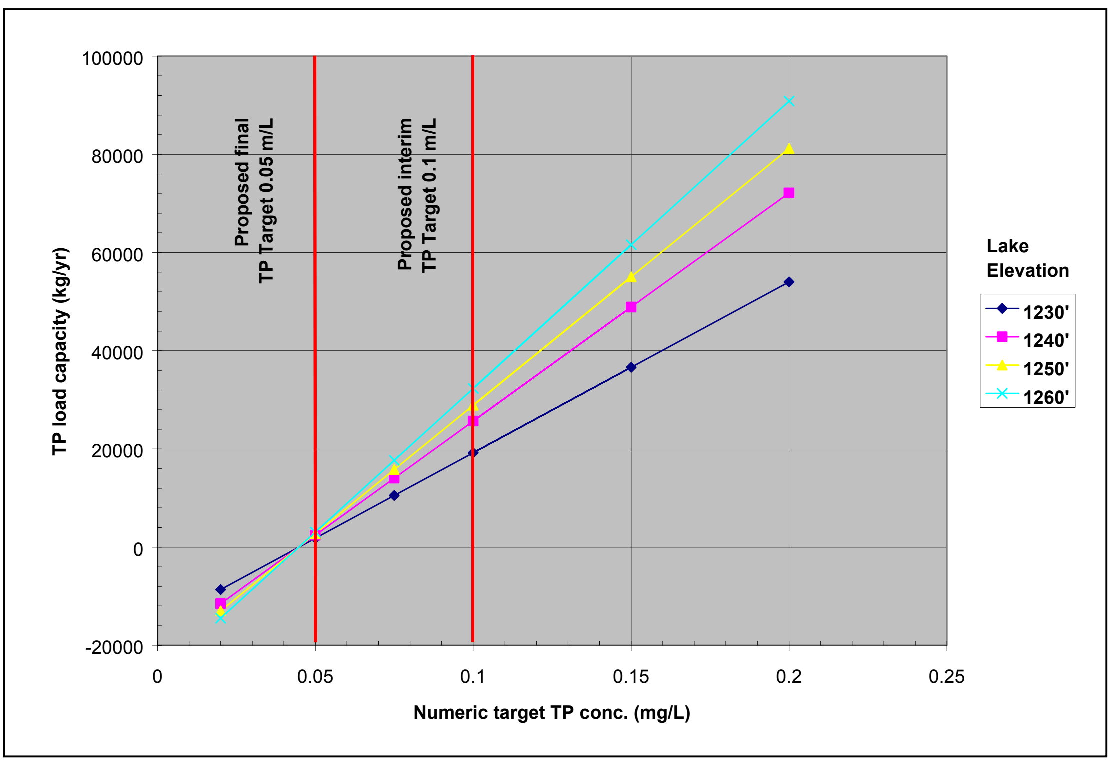

Figure 6-2. Total external phosphorus load capacity of Lake Elsinore under different in-lake total phosphorus concentrations assuming 70% reduction in internal loading rate

6.2 Canyon Lake Total Phosphorus Concentration Model

In order to make water quality predictions and establish the link between phosphorus loadings to Canyon Lake and in-lake total phosphorus concentrations, a simplified steady-state model similar to the model developed for Lake Elsinore was also developed for Canyon Lake.

$$\mathbf{C_{ss} = ((Q_{in}C_{in} - Q_{out}C_{out})/V)*H/v_{net}}$$

solving for the allowable external TP load ($Q_{in}C_{in}$):

$$\mathbf{Q_{in}C_{in}\ (external\ TP\ load) = C_{ss} * v_{net} *V/H + Q_{out}C_{out}}$$

where:
Q_{in} = flow entering Canyon Lake (m^3/yr)
C_{in} = TP concentration entering Canyon Lake (mg/L)
C_{ss} = in-lake TP concentration (mg/L) ***(numeric target)***
v_{net} = phosphorus sedimentation rate (m/yr)
V = lake volume of (m^3)
H = average lake depth (m)
Q_{out} = outflow from Canyon Lake (m^3/yr)
C_{out} = TP concentration leaving Canyon Lake (mg/L)

The net sedimentation rate of phosphorus, (v_{net}), was determined from historical phosphorus concentration data, and reflects the loss of phosphorus by algal uptake and sedimentation minus internal loading and re-suspension. Unlike Lake Elsinore, the relationship between phosphorus net sedimentation rate, sediment phosphorus release rate and re-suspension rate for Canyon Lake could not be developed for Canyon Lake because of the lack of data.

In Canyon Lake during the spring of 1998, fall of 1998, fall of 2000, spring of 2001 and fall of 2001, the TP concentration displayed a first order rate decay. The rate constants were calculated by fitting an exponential curve to each time period, yielding an average first order rate constant of 0.91/yr. Since rate constant = v_{net} /H, and the average water depth of Canyon Lake (H) during 1998, 2000 and 2001 was 7 m, v_{net} is then calculated to be 6.4 ± 0.8 m/yr. During dry years, the outflow (Q_{out}) from Canyon Lake is equal to zero. Outflows from Canyon Lake during wet and moderate years (as represented by 1998 and 1994, respectively) predicted by the EFDC model were used to provide Q_{out} values of 133,981 and 2,641 acre-feet, respectively.

Phosphorus Load Capacity for Canyon Lake Based on Proposed Interim Target

Substituting the proposed interim phosphorus numeric target of 0.1 mg/L (or 100 mg/m^3) into the above equation results in an external TP load (Q_{in}*C_{in}) for Canyon Lake under various lake elevations (Table 6-3). Phosphorus load capacity increases significantly in wet years (1998), while during moderate conditions (1994), the total phosphorus load capacity only slightly increases as compared to dry conditions (Table 6-3). As for Lake Elsinore, these calculations fail to take into account the cumulative effect of nutrient loads on water quality and again, an average load approach is recommended. The average loads needed to assure compliance with the numeric targets are also shown in Table 6-3.

Table 6-3. Total external phosphorus TMDL for Canyon Lake to achieve the proposed interim target of 0.1 mg/L (for external load only)

Elevation* (feet asl)	Volume (AF)	Volume (m^3)	Area (acres)	Mean Depth (feet)	Mean Depth (m)	TP TMDL (kg/yr)
1372	7,152	8,796,960	426	16.79	5.1	1,099
1375	8,478	10,428,186	459	18.48	5.6	1,184
1381.8	11,868	14,597,640	525	22.61	6.9	1,355
1382	12,025	14,790,996	526	22.85	7.0	1,358
Canyon Lake spills at greater than 1382.1’						
Moderate year as in 1994						1,664
Wet year as in 1998						17,838
Average						**4,083**

* Typical Canyon Lake elevations under wet conditions is 1382’ or greater. Under moderate conditions, the lake elevation ranges from 1375 to 1382’; under dry conditions, lake elevation is below 1375’.

A point should be made with regard to differences between the assumptions made for Canyon Lake versus Lake Elsinore. First, staff assumed that there would be no reduction in the internal phosphorus sediment load for Canyon Lake. At this time, the effect of lake management practices (aeration, dredging, and/or possible alum addition) on phosphorus release rates in Canyon Lake has not been determined. Literature reviews indicate that phosphorus release from sediment is controlled by several factors, including water column sulfate concentration (Caraco *et al*., 1989), redox potential, mixing intensity, temperature, bioturbation and sediment types (Holdren and Armstrong, 1980). Therefore, until additional studies are conducted, no reduction in the internal load of phosphorus for Canyon Lake is assumed

Phosphorus Load Capacity for Canyon Lake Based on Proposed Final Target

As for Lake Elsinore, the total phosphorus TMDL (load capacity) needed to meet the proposed final numeric target of 0.05 mg/L for Canyon Lake was also calculated. Results of this analysis are shown in Table 6-4 and Figure 6-3. The phosphorus load capacity increases significantly in a wet year (1998), while during the moderate year (1994), the total phosphorus load capacity only slightly increases as compared to the dry years (see Table 6-4 and Figure 6-3).

Table 6-4. Total external phosphorus TMDL for Canyon Lake to achieve the proposed final target of 0.05 mg/L

Elevation* (feet asl)	Volume (AF)	Volume (m^3)	Area (acres)	Mean Depth (feet)	Mean Depth (m)	TP TMDL (kg/yr)
1372	7,152	8,796,960	426	16.79	5.1	550
1375	8,478	10,428,186	459	18.48	5.6	592
1381.8	11,868	14,597,640	525	22.61	6.9	678
1382	12,025	14,790,996	526	22.85	7.0	679
Canyon Lake spills at greater than 1382'						
Moderate year as in 1994						897
Wet year as in 1998						8,919
Average						**2,053**

* Typical Canyon Lake elevation under wet conditions is at 1382' or greater. Under moderate conditions, the lake elevation ranges from 1375 to 1382'; under dry conditions, lake elevation is below 1375'.

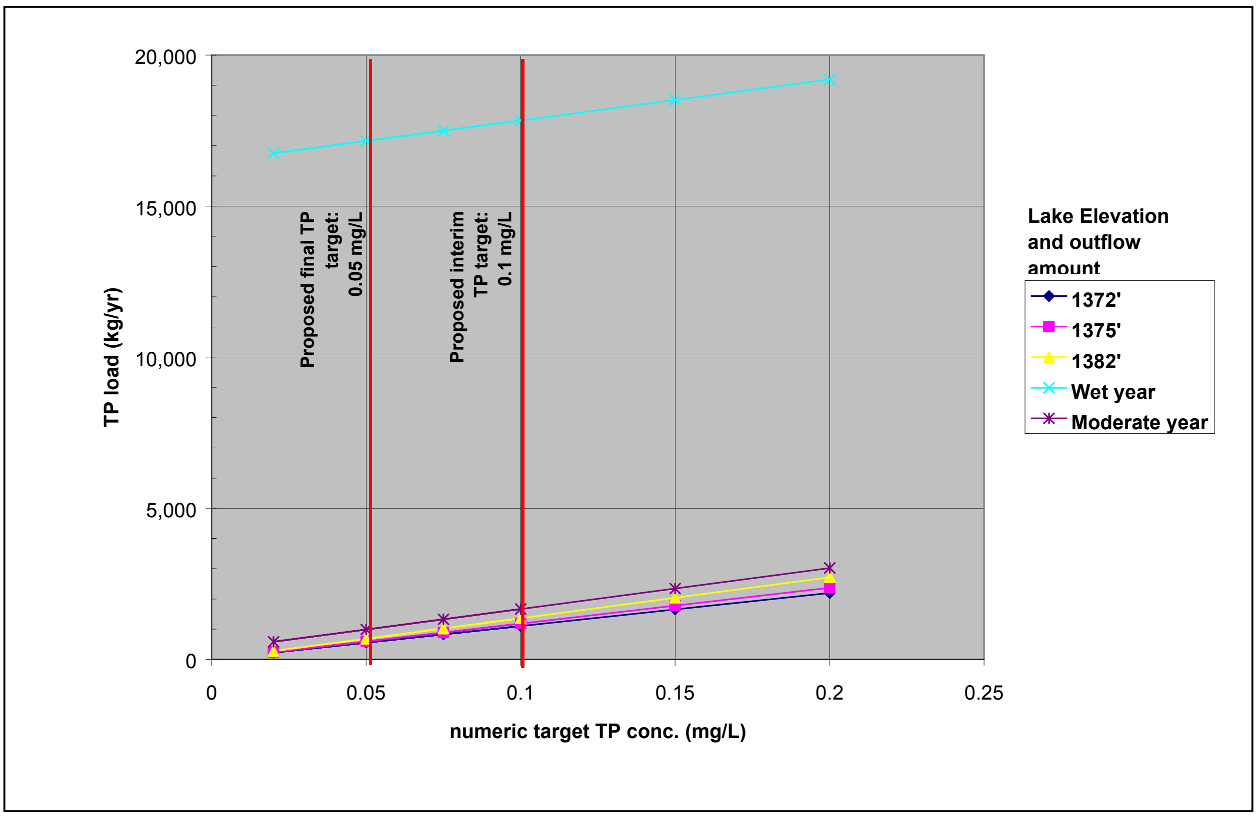

Figure 6-3. Total external phosphorus load capacity of Canyon Lake under different in-lake total phosphorus concentrations and different lake elevations and outflow amounts

6.3 Nitrogen TMDL (Load Capacity) for Lake Elsinore and Canyon Lake

Nitrogen load capacity for both lakes for the three hydrological conditions was calculated by multiplying the proposed numeric target for both lakes by the flow into the lakes.

$$\textbf{TN TMDL} = \mathbf{Q_{in}} \ast \textbf{numeric target}$$

For Lake Elsinore, the total inflow volume was determined by adding the local runoff volume to the overflow volume from Canyon Lake. Estimated annual runoff volumes from the local watershed surrounding Lake Elsinore were 945 AFY in 1994, 8,502 AFY in 1998, and 3,155 AFY in 2000 (Tetra Tech Inc., 2003). The overflows from Canyon Lake were 2641 AFY for 1994, and 133,981 AFY for 1998. For Canyon Lake, the inflow volume was calculated from the lake elevation data and the stage curve during dry years when the lake did not overflow. During wet and moderate years when Canyon Lake overflowed, the total inflow was assumed to equal the sum of the volume increase based on the elevation change before Canyon Lake spills that overflow volume.

The total nitrogen TMDLs for Lake Elsinore and Canyon Lake to achieve the interim target of 1.0 mg/L total nitrogen and the final target of 0.5 mg/L are listed in Tables 6-3 and 6-4, respectively. Again, these tables list average total nitrogen loading capacity to address the cumulative impacts of nutrient loads, irrespective of hydrologic condition.

Table 6-5. Lake Elsinore and Canyon Lake External Total Nitrogen TMDL (load capacity) for proposed interim target of 1.0 mg/L

Lake Elsinore					
	Flow Acre-ft/yr	Flow (m^3/yr)	TN target (mg/L)	TN Target (kg/m^3)	TN load capacity (kg/yr)
Wet	142,483	175,254,090	1	0.001	175,254
Moderate	3,586	4,410,780	1	0.001	4,411
Dry	315	387,450	1	0.001	387
Average					**60,017**
Canyon Lake					
	Flow Acre-ft/yr	Flow (m^3/yr)	TN target (mg/L)	TN Target (kg/m^3)	TN load capacity (kg/yr)
Wet	139,345	171,394,350	1	0.001	171,394
Moderate	5,812	7,148,760	1	0.001	7,149
Dry	3,578	4,400,940	1	0.001	4,401
Average					**60,981**

Table 6-6. Lake Elsinore and Canyon Lake External Total Nitrogen TMDL (load capacity) for proposed final target of 0.5 mg/L

Lake Elsinore					
	Flow (Acre-ft/yr)	Flow (m^3/yr)	TN target (mg/L)	TN Target (kg/m^3)	TN load capacity (kg/yr)
Wet	142,483	1.75E+08	0.5	0.0005	87,627
Moderate	3,586	4410780	0.5	0.0005	2,205
Dry	315	387450	0.5	0.0005	194
Average					**30,009**
Canyon Lake					
	Flow Acre-ft/yr	Flow (m^3/yr)	TN target (mg/L)	TN Target (kg/m^3)	TN load capacity (kg/yr)
Wet	139,345	1.71E+08	0.5	0.0005	85,697
Moderate	5,812	7,148,760	0.5	0.0005	3,574
Dry	3,578	4,400,940	0.5	0.0005	2,200
Average					**30,491**

6.4 Proposed TMDLs

Tables 6-7 and 6-8 summarize the proposed phosphorus and nitrogen TMDL for both Lake Elsinore and Canyon Lake to achieve the interim and final numeric targets. Included are the proposed allowable load from all external sources and the allowable load from internal sediments. The asterisked notation in Table 6-7 warrants specific mention. Comparison of the average external nitrogen load capacity (allowable average external nitrogen load) to meet the interim nitrogen target in Canyon Lake (60,981 kg/yr (Table 6-5)) to the average existing external nitrogen load (53,131 kg/yr (Table 5-11)) shows that the average existing external load is less than the load capacity. Given the cumulative effects of nutrient loads, it is not sensible to allow higher than existing loads. Therefore, in the case noted, the average existing external load was used as the basis for the external load TMDL, rather than the calculated load capacity.

The next section will discuss how these loads are allocated amongst all sources.

Table 6-7. Nutrient TMDL to achieve the interim targets of phosphorus (0.1 mg/L) and nitrogen (1 mg/L) for Canyon Lake and Lake Elsinore (to be met as soon as possible, but no later than 2009) (all numbers in kg/yr)

	Phosphorus		Nitrogen	
	Lake Elsinore	Canyon Lake	Lake Elsinore	Canyon Lake
Internal Loading	21,554+	4,625	197,370	13,549
External Loading	9,951	4,083	60,017	53,132*
Total TMDL	31,505	8,708	257,387	66,680

* The calculated external nitrogen load capacity turned out to be greater than the model-simulated existing nitrogen load. To allow more load than the existing load doesn't make sense. Therefore, the simulated existing load is used for TMDL allocation.

+ Assumes 35% reduction in internal phosphorus loading

Table 6-8. Nutrient TMDL to achieve the interim targets of phosphorus (0.05 mg/L) and nitrogen (0.5 mg/L) for Canyon Lake and Lake Elsinore (to be met as soon as possible, but no later than 2019) (all numbers in kg/yr)

	Phosphorus		Nitrogen	
	Lake Elsinore	Canyon Lake	Lake Elsinore	Canyon Lake
Internal Loading	9,948+	4,625	197,370	13,549
External Loading	2,895	2,053	30,009	30,491
Total TMDL	12,843	6,678	227,379	44,040

+ Assumes 70% reduction in internal phosphorus loading

7.0 Proposed Lake Elsinore and Canyon Lake Total Phosphorus and Total Nitrogen Waste Load Allocations and Load Allocations

As discussed in Section 5, nutrient sources to Canyon Lake and Lake Elsinore come from both point source and nonpoint source discharges. In order to derive the proposed waste load allocations (WLAs) for point source discharges and load allocations (LAs) for nonpoint source discharges, staff utilized the model results from Tetra-Tech and in-lake sediment release studies from Anderson to determine current nitrogen and phosphorus loading. Staff then determined the reductions required from all sources in order to meet the proposed TMDLs.

The TMDL, WLA and LA take into consideration the cumulative effect of the watershed hydrological conditions. The approach employed allocates the phosphorus and nitrogen TMDL calculated in Section 6 (Tables 6-7 and 6-8), based on average external load capacity, to the sources to facilitate implementation. In addition, the TMDL allocation applies to a 5-yr running average, meaning that phosphorus and nitrogen loads from each source will be continuously monitored for 5 years, and the average of the load over the five years shall not exceed the TMDL allocation. This approach takes in account the cumulative effect of nutrient loads from year to year[9].

Point sources discharges of nutrients to Canyon Lake and Lake Elsinore include urban storm and non-stormwater runoff (MS4) and discharges from confined animal feeding operations (CAFOs). Recycled water discharges to Lake Elsinore by Eastern Municipal Water District (EMWD) and/or Elsinore Valley Municipal Water District (EVMWD), which are intended to maintain the lake level, are an additional point source of nutrients. While not now regulated as a point source discharge, Colorado River Water is used to supplement and maintain the lake level in Canyon Lake.

Nonpoint source discharges of nutrients considered in the Tetra Tech simulations include those from on-site disposal systems (septic systems), agricultural runoff, atmospheric deposition, open space/forest runoff and internal loading from lake sediments.

Proposed WLAs and LAs to achieve the interim and final phosphorus and nitrogen targets for all nutrient sources for Lake Elsinore and Canyon Lake are shown in Tables 7-1, and 7-2, respectively. The following discussion describes the approach used to determine the LA and WLA for each of these nutrient sources.

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[9] In developing this TMDL, the wasteload and load allocations for each source were initially calculated based on the allowable loads under wet, moderate and dry conditions (represented by lake elevation and volume (Tables 6-1 through 6-6), rather than the average loads. In other words, three sets of wasteload and load allocations were identified, each pertaining to one of the hydrologic conditions. These are presented in Appendix A. In some cases, particularly under the wet scenario, the calculated allowable allocations for the sources were higher than existing loads. This correlates with the finding, described in Section 6, that the load capacity of the lakes is higher under wet conditions, due to increased lake elevation and volume. However, a TMDL approach that would allow higher than existing loads under any condition makes no sense and fails to take into account the cumulative effect of nutrient loads to the lakes (see discussion at end of Section 5). In additional, having separate TMDL allocations for different hydrologic conditions makes implementation difficult. It requires the accurate prediction of hydrologic condition in any given year. Such prediction is not feasible at the present time. Therefore, a revised approach utilizing average allowable loads is recommended as the basis for determining wasteload and load allocations.

Lake Elsinore Supplemental Water

The average amount of supplemental water needed to maintain Lake Elsinore levels at 1240 to 1247 feet (considered the appropriate operation range)[10] is 8,800 AFY. Under worst-case drought conditions, up to 13,800 AFY of supplemental water may be needed to maintain the lake elevation above 1240 feet (CH2M Hill, 2003). Of these amounts, 5000 AFY is assumed to come from the groundwater via three island wells, while the rest would come from recycled wastewater from either EMWD or EVMWD (CH2M Hill, 2002). Nitrogen and phosphorus concentrations in well water are below detection limit (0.02 mg/L for TP and 0.1 mg/L for TN), therefore, no nutrient load is allocated to well water.

Currently, the total phosphorus concentration of recycled water from the EVMWD Treatment Plant averages 2.12 mg/L, while the total phosphorus concentration of EMWD recycled water averages 0.28 mg/L[11]. The average total nitrogen concentration of the recycled water from the EVMWD Treatment Plant and the EMWD recycled water are 7.16 mg/L and 8.1 mg/L, respectively (Anderson and Nascimento, 2003). The difference in the SRP quality between EVMWD and EMWD is due to the fact that EMWD's new treatment plants are designed to reduce phosphorus concentrations to 0.5 mg/L (Montgomery Watson, 2000). Staff believes that it is reasonable and feasible to assume that all recycled water discharged to the lake will have a phosphorus concentration of 0.5 mg/L, or less[12]. To determine the allocations necessary to achieve the interim targets, it is assumed that recycled water quality will be limited to 0.5 mg/L TP and 1mg/L total nitrogen. Using a total volume of recycled water of 3,300 acre-feet, the total phosphorus and total nitrogen waste load allocation to meet the interim target are calculated to be 2,030 kg/yr and 4,059 kg/yr, respectively. Under the worst case drought condition when 8,800 acre-feet/yr recycled water may be needed for Lake Elsinore, the waste load allocations for phosphorus and nitrogen would be 5,412 kg/yr and 10,824 kg/yr, respectively, to meet the interim targets. Employing the average approach that staff recommends, the interim waste load allocations for phosphorus and nitrogen for the recycled water are 3,721 kg/yr and 7,242 kg/yr, respectively. However, the external phosphorus load capacity to meet the final phosphorus numeric target of 0.05 mg/L, is 2895 kg/yr and 30,009 kg/yr, respectively. A more stringent phosphorus WLA is necessary to meet the final phosphorus target of 0.05 mg/L. For the purposes of determining allocations to achieve the proposed final phosphorus target, it is assumed that the phosphorus concentration in the recycled water quality will be limited to 0.2 mg/L. As already noted, the recommended permit will likely include an offset provision.

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[10] This is the lake operation range proposed by the Lake Elsinore and San Jacinto Watershed Authority, which is different than the lake operation range proposed by the Lake Elsinore Management Authority (LEMA) in the 1990s.

[11] EMWD has several treatment plants in the San Jacinto Watershed. The 0.28 mg/L SRP concentration is an average concentration of phosphorus discharged to Lake Elsinore in 2003.

[12] It is anticipated that the discharge permits for EMWD/EVMWD would specify compliance with a numeric limit for phosphorus of 0.5 mg/L or less, and that the permits would also allow the implementation of an offset program, should strict compliance with this numeric limitation be demonstrated to be infeasible. Implementation of an offset program in lieu of strict compliance with the numeric limit would require the discharger to assure removal from the lake of phosphorus discharged above the numeric limit on at least a one-to- one basis.

Canyon Lake Supplemental Water

On occasion, EVMWD purchases Colorado River water from the Metropolitan Water District to ensure that Canyon Lake levels are maintained at 1372 feet. Colorado River water has very low nitrogen and phosphorus concentrations (0.2 mg/L and non-detect, respectively) (EVMWD, personal communication, 2001). The most recent addition of supplemental water to Canyon Lake occurred in April 2002 (1,006 AF was added). With the nitrate-nitrogen and total phosphorus concentrations shown above, the total nitrogen WLA for Canyon Lake supplemental water is 247 kg/yr and the total phosphorus WLA is zero.

Atmospheric Deposition

The proposed load allocation for atmospheric deposition is the same as the estimated existing load discussed in Section 5 (Canyon Lake: TN = 1,918 kg/yr, TP = 221 kg/yr; Lake Elsinore: TN = 11,702 kg/yr, TP = 108 kg/yr). Overall, atmospheric deposition constitutes a small portion of the total nutrient loads to both lakes. Staff believes that reduction of this load is not feasible, and furthermore, would make little relative difference in attaining the proposed TMDL.

Internal Sources

To determine the internal loading allocation for Lake Elsinore, staff assumed that Lake aeration is in place to reduce the internal phosphorus sediment load by 35% in order to meet the proposed interim total phosphorus TMDL and interim numeric target of 0.1 mg/L (see discussion in Section 6). A 70% reduction in internal phosphorus loading rate is assumed in order to meet the final numeric phosphorus target of 0.05 mg/L. Aeration appears to have no effect on the release of nitrogen from sediments (Anderson, 2000). Therefore, no reduction in the internal nitrogen load to Lake Elsinore is assumed or proposed for the purposes of the load allocation.

For Canyon Lake, because no studies have been conducted on the efficiency of treatment methods, and because there are no plans to build and/or treat the internal nutrient sources, staff does not propose a reduction in the sediment phosphorus or nitrogen loads to Canyon Lake. As shown in Table 7-1, the existing internal nutrient release rates for nitrogen and phosphorus in Canyon Lake are allocated as the proposed interim and final LAs, (4,625 kg/yr of phosphorus and 13,549 kg/yr of nitrogen).

Urban Storm and Non-stormwater Runoff, Confined Animal Feeding Operations, Agriculture, Open/Forest, and Septic Systems

The remaining existing or potential nutrient sources, urban runoff, CAFOs, agriculture, open space/forest runoff, and septic systems, originate from the various land use practices in the watershed. To determine the WLAs for urban and CAFO nutrient discharges and the LAs for agriculture, open space/forested lands and septic systems, staff calculated the allowable load from these sources, taking into consideration the assumed WLA for supplemental water and the LAs for internal sediment sources and atmospheric deposition as follows:

$$\mathbf{TMDL = \Sigma WLA + \Sigma LA + MOS}$$

where:

ΣWLA = supplemental water WLA + CAFO WLA + Urban (MS4) WLA
ΣLA = agriculture LA + septics LA + open/forest LA + internal sediment LA
MOS = margin of safety was incorporated via conservative assumptions, therefore no explicit MOS is specified (see Section 8.0)

Proposed WLAs for supplemental water and the proposed LAs for atmospheric deposition and internal sediment load are discussed above. The allocations for the remaining land use based sources are all considered together as follows:

MS4 WLA + CAFO WLA + Ag LA + open LA + septic LA =TMDL – supple. water WLA – atmos LA – internal loading

To determine the nitrogen and phosphorus allocations for each of the land use- based sources (the left side of the above equation), the respective percentage of the average nutrient load for each source was used (Table 5-11). Even though the EFDC predicted a significant nutrient contribution from Canyon Lake to Lake Elsinore, Canyon Lake was not given a load allocation because the nutrients from Canyon Lake were originally from the watershed and therefore those loads will be allocated to the sources in the San Jacinto River watershed.

Table 7-1 lists the proposed waste load allocations for point sources, load allocations for nonpoint sources and the comparison to the existing loads estimated from the LSPC model, as well as the percentage load reduction required in order to meet the proposed interim nutrient targets.

The same approach is used to determine the phosphorus and nitrogen WLAs and LAs for all potential sources to achieve the proposed final numeric targets. Table 7-2 lists the nitrogen and phosphorus waste load allocations, load allocations, in comparison to the average existing loads estimated from the LSPC model, and the percentage load reduction required in order to meet the proposed final nutrient targets.

The TMDL allocations proposed in Tables 7-1 and 7-2 apply to a 5-year running average, meaning that the average loads from each source over the 5-year period shall not exceed the allocations specified in the Tables. Proposed allocations to meet the interim targets (Table 7-1), are to be achieved as soon as possible, but no later than 2009. Likewise, the proposed allocations to meet the final targets (Table 7-2) are to be achieved as soon as possible, but no later than 2019. This approach takes into account the cumulative impact of nutrients on lake water quality, and overcomes the limitation of the model used to calculate the nutrient load capacity of the lakes which was stated in Section 6. This approach also provides sufficient time for the stakeholders in the watershed to plan and implement nutrient control measures to meet the TMDL proposed to achieve targets. In addition, it allows Regional Board staff and the stakeholders to continue monitoring of the watershed and lakes and to refine the TMDL if, and as necessary.

Table 7-1 Proposed Interim TMDL, Wasteload and Load Allocations for Lake Elsinore and Canyon Lake (to be achieved as soon as possible, but no later than 2009)

Lake Elsinore

	Nitrogen Load Allocation (kg/yr)[b]	Existing TN Load (kg/yr)[a]	Reduction (%)	Phosphorus Load Allocation (kg/yr)[b]	Existing TP Load (kg/yr)[a]	Reduction (%)
TMDL	**257,387**	**419,090**	39	**31,505**	**82,422**	62
WLA	18,072	73,012		4,739	17,446	
Supplemental water*	7,442	59,532	87	3,721	14883	75
Urban	6,692	8,486	21	635	1599	60
CAFO	3,938	4,994	21	383	964	60
LA	239,315	346,078	31	26,766	64,976	
Internal Sediment Source	197,370	197,370	0	21,554	33,160	35
Atmospheric Deposition[c]	11,702	11,702	0	108	108	0
Agriculture	14,094	17,873	21	2,966	7473	60
Open/Forest	5,630	7,141	21	1,733	4366	60
Septics	10,519	13,341	21	405	1021	60
Export from Canyon Lake**	0	98,651			18848	
MOS* **	0			0		

Canyon Lake

	Nitrogen load	Existing TN	Reduction	Phosphorus Load	Existing TP	Reduction
	Allocation (kg/yr)	load (kg/yr)	(%)	Allocation (kg/yr)	Load (kg/yr)	(%)
TMDL	**66,680**	**66,680**	**0**	**8,708**	**20,649**	58
WLA	13,807	13,807		660	2,699	
Supplemental water+	248	248	0	0	0	
Urban	8,391	8,391	0	419	1713	76
CAFO	5,168	5,168	0	241	986	76
LA	52,873	52,873	0	8,049	17,950	
Internal Sediment Source	13,549	13,549	0	4,625	4,625	0
Atmospheric Deposition[c]	1,918	1,918	0	221	221	0
Agriculture	18,567	18,567	0	1,946	7962	76
Open/Forest	6,477	6,477	0	1,025	4193	76
Septics	12,362	12,362	0	232	949	76
MOS***						

* The WLA allocation for supplemental water to Lake Elsinore only considered the recycled water.
** The source "Export from Canyon Lake" was not given any load allocation. Instead, the load was given to the sources in the watershed.
*** Implicit Margin of safety is considered due to the conservative approach in numeric target selection (see Section 8 for further discussion).
[+] The WLA for supplemental water to Canyon Lake was calculated based on the recent addition of the Colorado River water to Canyon Lake.
[a] See Table 5-11
[b] See Table 6-7
[c] The atmospheric deposition loads were derived from literature value and local precipitation data.

Table 7-2 Proposed Final TMDL, Wasteload and Load Allocations for Lake Elsinore and Canyon Lake (to be achieved as soon as possible, but no later than 2019)

Lake Elsinore

	Nitrogen load Allocation (kg/yr)[b]	Existing TN load (kg/yr)[a]	Reduction (%)	Phosphorus Load Allocation (kg/yr)[b]	Existing TP Load (kg/yr)[a]	Reduction (%)
TMDL	**227,379**	**419,090**	46	**12,843**	**82,422**	84
WLA	10,268	73,012		1,704	17,446	
Supplemental water*	7,442	59,532	87	1,488	14883	90
Urban	1,779	8,486	79	135	1599	92
CAFO	1,047	4,994	79	81	964	92
LA	217,111	346,078		11,139	64,976	
Internal Sediment Source	197,370	197,370	0	9,948	33,160	70
Atmospheric Deposition[C]	11,702	11,702	0	108	108	0
Agriculture	3,746	17,873	79	629	7473	92
Open/Forest	1,497	7,141	79	368	4366	92
Septics	2,796	13,341	79	86	1021	92
Export from Canyon Lake**	0	98,651			18848	0
MOS* **	0			0		

Canyon Lake

	Nitrogen load Allocation (kg/yr)	Existing TN load (kg/yr)	Reduction (%)	Phosphorus Load Allocation (kg/yr)	Existing TP Load (kg/yr)	Reduction (%)
TMDL	**44,041**	**66,680**	34	**6,678**	**20,649**	68
WLA	7,784	13,807		313	2,699	
Supplemental water[+]	248	248	0	0	0	
Urban	4,664	8,391	44	199	1713	88
CAFO	2,872	5,168	44	114	986	88
LA	36,257	52,873		6,365	17,950	
Internal Sediment Source	13,549	13,549	0	4,625	4,625	0
Atmospheric Deposition[c]	1,918	1,918	0	221	221	0
Agriculture	10,319	18,567	44	923	7962	88
Open/Forest	3,600	6,477	44	486	4193	88
Septics	6,871	12,362	44	110	949	88
MOS	0			0		

* The WLA allocation for supplemental water to Lake Elsinore only considered the recycled water.
** The source “Export from Canyon Lake” was not given any load allocation. Instead, the load was given to the sources in the watershed.
*** Implicit Margin of safety is considered due to the conservative approach in numeric target selection (see Section 8 for further discussion).
[+] The WLA for supplemental water to Canyon Lake was calculated based on the recent addition of the Colorado River water to Canyon Lake.
[a] See Table 5-11
[b] See Table 6-7
[c] The atmospheric deposition loads were derived from literature value and local precipitation data.

8. Margin of Safety, Seasonal Variations, and Critical Conditions

8.1 Margin of Safety

TMDLs must include an explicit or implicit margin of safety (MOS) to account for uncertainty in determining the relationship between pollutant loads and impacts on water quality. An explicit MOS can be provided by reserving (not allocating) part of the TMDL and therefore requiring greater load reductions from existing and/or future sources. An implicit MOS can be provided by conservative assumptions in the TMDL analysis.

Sources of uncertainty in the Lake Elsinore/Canyon Lake nutrient TMDL development analysis include: 1) the lack of watershed specific data on phosphorus and nitrogen loading from surface runoff; 2) the inherent seasonal and annual variability in delivery of phosphorus and nitrogen from external sources and nutrient cycling within Lake Elsinore and Canyon Lake;
3) assumptions made about the rate of nutrient release from the sediment and the efficiency of lake treatment technologies; and, 4) the lack of established relationships between external and internal nitrogen loads and in-lake nitrogen concentration. In addition, the water quality model developed to link the in-lake phosphorus concentration and internal load and external load suggests that the error range of phosphorus concentration depends on the error range of internal loading rate, net sedimentation rate and external load. The error range for the Lake Elsinore sedimentation rate was determined using historical data, however, because of the lack of data, determination of the error range for Canyon Lake internal loading rate and external load was not feasible.

Because of these uncertainties, staff selected the numeric target value conservatively (by using the 25th percentile of the nutrient concentration during the reference year). Staff also made conservative assumptions when developing the load allocations, (*e.g*., assuming a constant value for atmospheric deposition and internal loading). The phosphorus model parameters used to calculate the phosphorus load capacity were based on the study during dry conditions. In addition, the LSPC model used to simulate the load to lake used conservative literature values as well (*e.g*., assumptions used to simulate the nutrient runoff from the septic systems). All these approaches therefore address the MOS implicitly. As new data are collected under various hydrologic conditions, data gaps will be filled, a more robust uncertainty analysis can be conducted and the MOS and TMDL can be adjusted as appropriate.

8.2 Seasonal Variations and Critical Conditions

TMDLs must include consideration of seasonal factors and critical conditions. The US EPA's protocol for developing nutrient TMDLs (1999) defines "critical conditions" as "the combination of environmental factors (e.g., flow, temperature, etc.) that results in attaining and maintaining the water quality criterion and has an acceptably low frequency of occurrence."

All aquatic ecosystems, whether or not being affected by human activities, show seasonal and annual variations in the rates of nutrient input and internal cycling. Nutrient concentrations may be more important at certain times of the year. For example, in north temperate lakes, spring increases in water temperature and available solar radiation for photosynthesis can trigger spring algal blooms if adequate amounts of nutrients are present. The nutrients may be available in the winter, but low temperatures and short, cloudy days will inhibit blooms. Other symptoms of eutrophication such as dissolved oxygen depletion also vary seasonally or annually; impacts on recreation, aquatic life and water supply beneficial uses are generally the most severe during the period of summer thermal stratification and highest plant productivity. Algal blooms also occur when lakes turn over and the nutrients from the hypolimnion are brought to the photic zones.

In Lake Elsinore and Canyon Lake, external phosphorus and nitrogen loading occurs mostly in the winter and spring, due to California's wet winter/dry summer climate. Soluble phosphorus and nitrogen released from lake sediments is greatest during the summer, due to high temperature and low dissolved oxygen (Anderson, 2001). The aerobic release of phosphorus P and nitrogen from littoral sediment occurs during the warmer part of the year (Anderson and Oza, 2003). Although fishing and other recreational uses occur year-round at Lake Elsinore and Canyon Lake, the potential impact of eutrophication on recreational uses is also greatest in summer.

The nutrient TMDL for Lake Elsinore and Canyon Lake accounts for seasonal and annual variations in external and internal phosphorus loading, and associated impacts on beneficial uses, in several ways:

1) The assessment of nutrient sources to the lake specifically accounts for variations in hydrologic conditions (wet, moderate and dry) and the transport of nutrients to and from the lakes under these conditions. Similarly, the determination of load capacity accounts for variation based on hydrologic condition. While these seasonal differences are clearly recognized, an average approach is recommended to address cumulative impacts of nutrient loads, and to facilitate TMDL implementation.
2) The most critical condition for attainment of aquatic life and recreational uses in Lake Elsinore and Canyon Lake occurs during the summer, when the greatest release of phosphorus and nitrogen from the sediment occurs and warm temperatures promote algal growth resulting in the depletion of oxygen. The source analysis demonstrates that during the summertime, the predominant source of nutrients resulting in eutrophication is the internal loading from sediments. The proposed TMDL address this critical condition by requiring that the sediment phosphorus loading be reduced by 35% to meet the proposed interim target, and by 70% to meet the proposed final target.
3) As discussed in Section 6.4, in one instance, the calculated nitrogen load capacity for Canyon Lake exceeded the average existing load. In this case, the average existing load, rather than the load capacity, was used for allocation purposes.

9. Implementation Recommendations

Federal regulations require the State to identify measures needed to implement TMDLs in the state water quality management plan (Basin Plan) (40 CFR 130.6). California law requires that Basin Plans have a program of implementation to achieve water quality objectives. The implementation program must include a description of actions necessary to achieve the objectives, a time schedule for these actions, and a description of surveillance to determine compliance with the objectives. Staff proposes that the Lake Elsinore and Canyon Lake Nutrient TMDL be adopted as a Phased TMDL. The TMDL's phased implementation framework provides time to conduct further monitoring and assessment, including the development of needed in-lake dynamic models (see below) and refinement of the existing watershed model. The results of these studies may provide the analytical basis for modifying the TMDL, WLAs, LAs and/or other elements of the TMDL.

The proposed Basin Plan amendment, shown in Attachment A, includes an implementation plan and monitoring program designed to implement the TMDL and evaluate its effectiveness. Implementation is expected to result in compliance with the proposed nutrient TMDL and allocations for Canyon Lake and Lake Elsinore and thereby ensure protection of the beneficial uses of these waterbodies. The proposed implementation plan includes requirements directed at both point and nonpoint sources.

<u>Implementation Actions by Regional Board</u>
In order to implement the TMDL, WLAs and LAs, Board staff proposes that the Regional Board undertake the following actions. Proposed dates for implementation of these actions are specified in the proposed Basin Plan amendment (Attachment A).

- Establish New Waste Discharge Requirements
  The Regional Board shall issue a new NPDES permit to Elsinore Valley Municipal Water District for supplemental water discharges to Canyon Lake that incorporates the appropriate WLAs, compliance schedule and monitoring program requirements.

- Revise Existing Waste Discharge Requirements
  The Regional Board shall review and revise, as necessary, the following existing NPDES permits to incorporate the appropriate WLAs, compliance schedules and monitoring program requirements.

    - Waste Discharge Requirements for the Riverside County Flood Control and Water Conservation District, the County of Riverside and the Incorporated Cities of Riverside County within the Santa Ana Region, Areawide Urban Runoff, NPDES No. CAS 618033 (Regional Board Order No. R8-2002-0011)

    - General Waste Discharge Requirements for Concentrated Animal Feeding Operations (Dairies and Related Facilities) within the Santa Ana Region, NPDES No. CAG018001 (Regional Board Order No. 99-11).

- Waste Discharge and Producer/User Reclamation Requirements for the Elsinore Valley Municipal Water District, Regional Water Reclamation Facility Riverside County, Order No. 00-1, NPDES No. CA8000027.

- Waste Discharge Requirements for Eastern Municipal Water District, Regional Water Reclamation System, Riverside County, Order No. 99-5, NPDES No. CA8000188.

- Watershed-Wide Waste Discharge Requirements for Discharges of Storm Water Runoff Associated with New Developments in the San Jacinto Watershed, Order No. 01-34, NPDES No. CAG 618005.

- Review/Revise Water Quality Objectives in the Basin Plan to establish site specific nutrient criteria for Lake Elsinore and Canyon Lake.
  The Regional Board intends to consider revision/adoption of nutrient water quality objectives for both lakes. Given the budgetary constraints, this effort is likely to require substantive resource contributions from interested parties.

<u>Actions Recommended for Implementation by Other Agencies/Entities</u>

In order to ensure that effective nutrient control programs that achieve the appropriate interim and final WLAs and LAs are developed and implemented, staff proposes that the following requirements for the appropriate responsible entity be incorporated into the Implementation Plan. Proposed dates for implementation of these actions are specified in the proposed Basin Plan amendment (Attachment A).

- Development and implementation of a Nutrient Management Plan by agriculture operators;

- Public education, septic system maintenance and septic system maintenance enforcement is the responsibility of Riverside County Health Department and certain municipalities with their own oversight and permitting program. Staff proposes that the Basin Plan amendment specify a requirement for the Riverside County Health Department to develop and implement a Septic System Management Plan. The development and implementation of this plan would be coordinated with any new requirements established pursuant to AB 885[13].

- Revision to, and implementation of, the County of Riverside Drainage Area Management Plan (DAMP) by the Riverside County Flood Control and Water Conservation District and co-permittees in the San Jacinto River watershed to describe the measures to comply

[13] AB 885 amended the California Water Code to add Section 13290 – 13290.7 to require the State Board, in conjunction with the State Department of Health Services, the California Coastal Commission and county and/or city environmental health agencies to adopt regulations for the permitting, maintenance, monitoring and oversight of on-site disposal systems. The State Board is currently in the process of working with various stakeholders to develop the appropriate regulations.

with this TMDL. Pursuant to the terms of Areawide stormwater permit, provisions of the DAMP, and the water quality management plan (WQMP) may suffice to address TMDL requirements;

- Revision to, and implementation of, the San Bernardino National Forest and the Cleveland National Forest Management Plans to address nutrient discharges.

- Agricultural operators, Confined Animal Feeding Operation operators, the Riverside County Flood Control and Water Conservation District and co-permittees, the Riverside County Health Department and the US Forest Service, shall develop and implement a plan to address the in-lake nutrient loads from Lake Elsinore.

- Agricultural operators, Confined Animal Feeding Operation operators, the Riverside County Flood Control and Water Conservation District and co-permittees, the Riverside County Health Department and the US Forest Service, shall evaluate in-lake treatment options to control internal nutrient loading from Canyon Lake. These options should include but are not limited to, alum treatment, aeration/oxygenation, dredging, biomanipulation, and others.

<u>Implementation Schedule</u>

Regional Board staff proposes that the interim targets for both Canyon Lake and Lake Elsinore (see Section 4, Tables 4-1 and 4-3) and the allocations specified in Table 7-1 be met as soon as possible but no later than 2009. Staff recommends that the final targets (Tables 4-1 and 4-3) and allocations (Table 7-2) be met as soon as possible but no later than 2019.

10. Monitoring Program Recommendations

Section 13242 of the California Water Code specifies that Basin Plan implementation plans must contain a description of the monitoring and surveillance programs to be undertaken to determine compliance with water quality objectives. As part of the incorporation of the proposed Canyon Lake and Lake Elsinore Nutrient MDL into the Basin Plan, several monitoring requirements are proposed (Attachment A) in order to evaluate the effectiveness of actions and programs implemented pursuant to the TMDL. Since the Canyon Lake and Lake Elsinore Nutrient TMDL is a phased TMDL, follow-up monitoring and evaluation is essential to validate and revise the TMDL as necessary.

A. Watershed-wide Nutrient Water Quality Monitoring Program

A watershed-wide nutrient monitoring program was implemented in 2000 by Regional Board staff and stakeholders in the watershed. The purpose of this monitoring program has been to collect data needed to develop the nutrient TMDLs. The monitoring program consists of the collection of stream flow and water quality data in the San Jacinto River watershed, with a focus on collecting nutrient data from specific nutrient sources (e.g., septic systems, open space/forest lands, urban runoff, and CAFOs).

Staff believes that continuation of this watershed-wide monitoring program will be essential to track the effectiveness of the TMDL implementation plan and to track the effectiveness of source load reductions. Staff recommends that the Basin Plan amendment specify that all watershed dischargers continue to implement this watershed-wide nutrient monitoring program. All of the stream gauging stations built and operated as part of the watershed-wide monitoring program should also be operated and maintained on a continuing basis, and water quality samples should be collected from all stations at the same frequency to quantify nutrient loads from various sources in the watershed. The data generated will not only be used to evaluate TMDL compliance, but will also be used calibrate the watershed model developed for the watershed by Tetra-Tech, Inc.

B. Canyon Lake and Lake Elsinore In-lake Monitoring Programs

Regional Board staff and watershed stakeholders implemented a Canyon Lake and Lake Elsinore in-lake monitoring program in 2000. This program, which is on-going, consists of collection of water quality data at stations in both Canyon Lake and Lake Elsinore on a year-around basis. The purpose of this program is to allow evaluation of changes in lake water quality due to nutrient input or other environmental factors.

Staff proposes in the Basin Plan amendment that watershed stakeholders continue the in-lake monitoring programs to assess the response of the lakes to nutrient loadings and to determine if the load reductions result in the achievement of numeric targets (as proposed in Section 4).

C. Pollutant Source Monitoring

Monitoring of pollutant sources is needed to ensure that required reductions are being achieved to meet the WLAs, LAs and TMDL. As part of Phase II of the TMDL, these data will be used to refine the specified allocations, as appropriate. Specific monitoring program requirements for the following sources are proposed in the Basin Plan amendment.

- CAFOs
- Urban discharges
- Supplemental water discharges to Lake Elsinore
- Supplemental water discharges to Canyon Lake
- Agricultural discharges
- Septic system discharges

In addition, for some nutrient sources, specific data are needed to refine the watershed model or to develop specific BMPs. These needs, listed below, are also addressed in the proposed Basin Plan amendment.

- Agricultural dischargers: Studies need to be conducted to inventory crops grown in the watershed, the amount of manure and/or fertilizer applied to each crop and amount of nutrients released from the croplands. Evaluation of site-specific BMPs is also needed to determine their effectiveness and to determine compliance with the proposed LA.

- Septic systems: Currently, there are not a lot of data with regard to septic systems in the Canyon Lake/Elsinore watershed. When the source analysis was conducted, Tetra-Tech, Inc. had to make assumptions based on literature values with regard to loading of nutrients from septic systems. Staff believe it is necessary to conduct studies on the impact septic systems have on Canyon Lake and Lake Elsinore nutrient water quality, as well as to track implementation of the septic system LA.

D. Special studies

Finally, staff believes that there is a need to conduct special, nutrient-related studies in the watershed.

- In-lake treatment of sediment to remove nutrients: The applicability of various in-lake treatment technologies to prevent the release of nutrients from lake sediments should be evaluated in order to develop a long-term strategy for control of nutrients from the sediment. Examples of treatment technologies include aeration, alum treatment, wetland treatment, fishery management, and dredging. Based on studies conducted in Lake Elsinore, aeration and fishery management[14] projects have been selected as viable options for addressing the nutrient in-lake sediment load, and are currently in progress. These types of studies should also be done for Canyon Lake.

- Model update/development: Dynamic models for the simulation of nutrient dynamics in Canyon Lake and Lake Elsinore should be developed to allow for the modeling of the fate and transport of nutrients in the lakes. As discussed in Section 4, only simplified water quality models exist for both lakes. Development of dynamic models will enable Regional Board staff and lake managers to determine the effect external watershed nutrient sources, as well as in-lake sediment nutrient sources, have on the kinetics of nutrient cycling, algal uptake, composition and decay rates, dissolved oxygen levels and fishery composition. Furthermore, dynamic models will be useful for future refinements of the TMDLs, WLAs, LAs as well as numeric targets.

  Update of the watershed nutrient model developed by Tetra-Tech, Inc will also be needed in the future as additional data are generated. An updated watershed model could be used to determine BMP effectiveness and to determine TMDL, WLA and LA compliance. The model could also be used as a tool to evaluate potential pollutant trading options.

- Monitoring to determine the relationship between ammonia toxicity and total nitrogen allocation to ensure that the total nitrogen TMDL allocation will protect the lakes from ammonia toxicity.

[14] The Lake Elsinore fishery management plan under development includes removal of bottom dwelling fish- carp and shad, and introduction of stripped bass. Nutrient release rates will be reduced through fishery management because the bio-turbation from carp and shad that contributes to nutrient releases will be controlled.

11. Economic Considerations

As previously stated, the Regional Board is required to include TMDLs in the Basin Plan. There are three statutory triggers for consideration of economics in basin planning. These triggers are:

- Adoption of an agricultural water quality control program (Water Code Section 13141). The Regional Board must estimate costs and identify potential financing sources in the Basin Plan before implementing any agricultural water quality control plan.
- Adoption of a treatment requirement or performance standard. The Regional Board must comply with the California Environmental Quality Act (CEQA) when amending the Basin Plan. CEQA requires that the Board consider the environmental effects of reasonably foreseeable methods of compliance with Basin Plan amendments that establish performance standards or treatment requirements, such as TMDLs. The costs of the methods of compliance must be considered in this analysis.
- Adoption of water quality objectives (Water Code Section 13241). The Regional Board is required to consider a number of factors, including economics, when establishing or revising water quality objectives in the Basin Plan.

It should be noted that in each of these cases, there is no statutory requirement for a formal cost-benefit analysis.

As discussed above, adoption of a TMDL does not constitute the adoption of new or revised water quality objectives, so the third statutory trigger does not apply here. However, implementation of this TMDL is likely to result in changes in agricultural operations to control nutrient runoff. Similarly, implementation of this TMDL will likely necessitate changes in programs (including educational programs and BMPs) designed to reduce nutrient inputs from urban stormwater or other sources. It is necessary, therefore, to consider the costs and potential funding mechanisms for the implementation of new/modified agricultural water quality control programs, and the costs of other measures that may be necessary to achieve (and monitor) compliance with the TMDL.

Information concerning the costs of implementation of this TMDL will be solicited during the public participation phase of consideration of this TMDL. Specifically, potentially affected parties will be asked to evaluate the TMDL-related costs. The following list identifies possible sources of funding.

A. Grant Programs

1. US EPA Clean Water Act 319(h) Program The Division of Water Quality, State Water Resources Control Board (SWRCB) administers water quality grants funded by the Federal Clean Water Ac (CWA) section 319 grant program. CWA section 319 funds may be used for implementation actions to prevent, control and/or abate nonpoint source (NPS) water pollution http://wwww.swrcb.ca.gov/nps/cwa_rfps.html

UC Cooperate Extension in Riverside County has applied for a Section 319 grant to assess and implement BMPs to reduce nutrient loads from croplands to Canyon Lake and Lake Elsinore. The proposal is under review by the State Board.

2. Proposition 13. In March 2000, California voters approved Proposition 13 (2000 Water Bond), which authorizes the State of California to sell $1.97 billion in general obligation bonds to support safe drinking, water quality, flood protection and water reliability projects throughout the state. The State Water Resources Control Board (SWRCB) will help allocate $763.9 million of these funds to local projects throughout California. A portion of the Proposition 13 funds, $15 million, has been set aside to support projects for Lake Elsinore restoration and San Jacinto River Watershed protection. A joint powers authority, the Lake Elsinore and San Jacinto Watershed Authority (LESJWA), comprised of the Cities of Lake Elsinore, Canyon Lake, Elsinore Valley Municipal Water District, County of Riverside and SAWPA, was formed to administer the funds. The projects under construction and consideration include: Lake Elsinore de-stratification; Lake Elsinore aeration; Lake Elsinore carp removal and fishery management; Canyon Lake de-stratification and aeration; Canyon Lake dredging; and nutrient removal from recycled water and Lake Elsinore water. All these projects should improve water quality in Lake Elsinore and Canyon Lake, if and when implemented. Regional Board staff are working closely with LESJWA board staff to ensure that the TMDL will be consistent with the objectives of the projects considered. SAWPA has also applied for a Proposition 13 grant to support the TMDL monitoring and to upgrade the watershed and lake modeling efforts. This proposal is also under review by the State Board.

3. State Board/Regional Board Funds- NPS Program funding sources: http://www.swrcb.ca.gov/nps/ofundsrc.html

B. Private financing (corporations or individuals)

C. Public financing (local agencies)
    1. State loan programs
    2. Local tax funds

12. California Environmental Quality Act (CEQA)

The Secretary of Resources has certified the Basin Planning process as functionally equivalent to the preparation of an Environmental Impact Report (EIR) or a Negative Declaration pursuant to the California Environmental Quality Act (CEQA). However, in lieu of these documents, the Regional Board is required to prepare the following: the Basin Plan amendment; an Environmental Checklist that identifies potentially significant adverse environmental impacts of the Basin Plan amendment; and, a staff report that describes the proposed amendment, reasonable alternatives, and mitigation measures to minimize any significant adverse environmental impacts identified in the Checklist. The Basin Plan amendment, Environmental Checklist, and staff report together are functionally equivalent to an EIR or Negative Declaration.

The draft Environmental Checklist (Attachment C to this report) concludes that there would be no potentially significant impacts on the environment caused by adoption of this Basin Plan amendment. Therefore, no mitigation measures are required.

This staff report will be followed by another report that includes comments received on the proposed amendment, staff responses to those comments, and a discussion of any changes made to the proposed amendment as the result of the comments or further deliberation by the Board, and/or Board staff. This follow-up report would address any additional CEQA considerations, including economics, that might arise as the result of any changes to the proposed amendment.

Consideration of Alternatives

1. No Project Alternative
   The "No Project" alternative would be no action by the Regional Board to adopt a TMDL with implementation measures and a monitoring program. This alternative would not meet the purpose of the proposed action, which is to correct ongoing violations of Basin Plan narrative objectives regarding algal growth and adverse impact to beneficial uses. This alternative would result in continuing water quality standards violations and threat to public health and safety, and the local economy. This alternative would not comply with the requirements of the Clean Water Act.

2. Alternatives
   The Regional Board could consider a TMDL based on alternative numeric targets, such as the literature values for mesotrophic/eutrophic classification. However, the proposed numeric targets are based on the best scientific information now available concerning the eutrophic status of Lake Elsinore and Canyon Lake and factors contributing to that status. The proposed targets provide the best assurance that the narrative water quality objective for algal growth will be achieved and that the beneficial uses will be protected. The proposed numeric targets are therefore consistent with the purpose of the TMDL.

   The Board could also consider an alternative TMDL implementation strategy that is based on a different compliance schedule approach. Adoption of a longer schedule would prolong non-attainment of the water quality standards. The proposed compliance schedule approach reflects the timing of implementation of projects proposed for Lake Elsinore and Canyon Lake by LESJWA, which are expected to result in improvement of Lake Elsinore and Canyon Lake. The proposed compliance schedule also considered the quality of available data for different hydrologic conditions and the needs for additional studies to fill data gaps and address uncertainties in TMDL calculation. The proposed compliance schedules are therefore, considered reasonable.

Finally, the Regional Board could consider an alternative TMDL approach that relies on wasteload and load allocations established for various hydrologic conditions. However, as discussed previously, such an approach would not account for cumulative nutrient loading and would be difficult to implement.

3. Proposed Alternative
   Staff believes that the recommended TMDL reflects a reasoned and reasonable approach to the improvement of beneficial uses of Lake Elsinore and Canyon Lake. The proposed implementation schedule also provides a realistic time frame in which to complete the tasks required by the TMDL.

13. Public Participation

In January 2000, Regional Board staff convened a TMDL Workgroup to assist staff in the development of the Lake Elsinore and Canyon Lake Nutrient TMDL. Active participants in the TMDL Workgroup include representatives from the Riverside County Flood Control and Water Conservation District, the cities of Lake Elsinore, Canyon Lake, Hemet and Moreno Valley, the Santa Ana Watershed Project Authority (SAWPA), the Lake Elsinore and San Jacinto Watershed Authority (LESJWA), the California Department of Fish and Game, Eastern Municipal Water District, Elsinore Valley Municipal Water District, Western Dairymen's Association, Milk Producers Council and the San Jacinto Resource Conservation District. The TMDL Workgroup has been instrumental in assisting Regional Board staff in the development of the Nutrient TMDL. Specific activities of the Workgroup have included compilation of existing data, design, coordination and implementation of the watershed and in-lake monitoring programs, and review of the results of studies conducted in the watershed by both Regional Board staff and other scientists.

In addition to the TMDL Workgroup, stakeholders in the watershed have formed the San Jacinto Watershed Council (Council). The Council includes members of the TMDL Workgroup; however, the Council's scope of activities extends beyond water quality and TMDL issues. For example, the Council has been working with Riverside County staff on issues dealing with the Multi-Species Habitat Plan. While not a member of the Council, Board staff does participate in Council meetings as time allows.

As discussed previously (see Section 5.2), SAWPA obtained a Clean Water Action Section 205(j) grant for conducting the nutrient assessment and modeling analysis. This project was instrumental in the development of the proposed Lake Elsinore and Canyon Lake Nutrient TMDL. In addition to the 205(j) funding, LESJWA obtained a Proposition 13 grant to develop a San Jacinto Watershed Nutrient Management Plan (NMP). The NMP was developed using the database, information and modeling tools utilized for the Lake Elsinore and Canyon Lake Nutrient TMDL development process[15]. An advisory group, a subcommittee of key watershed stakeholders on the San Jacinto Watershed Council, was consulted on a regular basis for input into the NMP. A draft of the San Jacinto Nutrient Management Plan has been completed and is currently under review. The final version is expected to be completed by May 2004.

The San Jacinto NMP provides a strategy for nutrient management in the watershed. The draft NMP discusses key issues regarding watershed characteristics, waterbody impairment, and provides a comprehensive pollutant source assessment with identification and recommendations for projects to reduce those sources of nutrients and improve the water quality in the watershed. Nineteen projects are identified in the draft San Jacinto NMP. Two of these projects are currently planned and funded for Lake Elsinore (through Proposition 13), and two are currently planned and funded for Canyon Lake. Several of the recommended projects propose continuation of the watershed and in-lake water quality monitoring programs. The remaining recommended projects would address nutrient sources and nutrient loading to Canyon Lake and Lake Elsinore

[15] Tetra Tech, Inc., the contractor for the TMDL model development, has also been one of the primary contractors for development of the San Jacinto NMP. Pat Boldt Consulting is the other contractor on the San Jacinto NMP project.

from the watershed through implementation of specific BMPs and/or construction of facilities to remove nutrient sources (*e.g.,* digesters). Table 13-1 provides the draft list of recommended projects and expected benefits. Note that most of the recommended projects will also implement specific elements of the proposed Nutrient TMDL (*e.g.,* monitoring programs, septic system improvements). However, due to that fact that detailed planning and design information is not available for most of the projects on the list at this time, it is not possible to assess whether the implementation of these projects will ensure the compliance of TMDL. Regional Board staff will continue to work closely with the TMDL Workgroup, the San Jacinto River Watershed Council, LESJWA and other stakeholders in the watershed to ensure that TMDL implementation efforts are consistent and coordinated with all of the other watershed improvement projects.

Table 13-1. Benefits of Projects Outlined in the Nutrient Management Plan

Project No.	Project Name	Pollutant Load Control	Habitat Protection	Aesthetic Value	Lake Water Quality	Lake Water Quantity	Addresses TMDL Development	Addresses TMDL Implementation & BMPs
1*	Lake Elsinore In-Lake Nutrient Treatment	X	X	X	X	X?		?
2*	Lake Elsinore Aeration	X	X	X	X			X
3*	Canyon Lake Aeration/ Destratification	X	X	X	X			X
4*	Canyon Lake Dredging	X	X	X	X	X		X
5	Lake Elsinore Water Quality Monitoring				X	X	X	X
6	Development of a Dynamic Water Quality Model of Lake Elsinore				X	X	X	X
7	Canyon Lake Water Quality Monitoring				X	X	X	X
8	Development of a Dynamic Water Quality Model of Canyon Lake				X	X	X	X
9	Structural Urban BMPs	X			X			X
10	Sewer and Septic Improvements	X			X			X
11	Control of Trash in Stream Channels	X	X	X	X			
12	Interception and Treatment of Nuisance Urban Runoff	X			X			X
13	Riparian Habitat Restoration and Development of Agricultural Buffers	X	X	X	X			X
14	Determination of Crop-Specific Agronomic Rates for Guidance in Fertilizer and Manure Application Management	X			X		X	X
15	Assessment of Nutrient Loads to the San Jacinto Watershed as a Result of Flooding in Agricultural Areas	X			X		X	X
16	Regional Organic Waste Digester	X			X			X
17	Development of a Pollutant Trading Model							X
18	Data Collection for Mystic Lake to Support Development of Future Projects		X		X		X	
19	Continued Monitoring of Streamflow and Water Quality Throughout the Watershed				X		X	X

* Projects that are being fully or partly funded by LESJWA.

(from the Draft San Jacinto Nutrient Management Plan by Tetra Tech, Inc., 2004)

14. Staff Recommendation

Direct staff to prepare a Basin Plan amendment and related documentation to incorporate the TMDL for nutrients for Canyon Lake and the Lake Elsinore that is shown in Attachment A for consideration at a future public hearing.

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